THE INFLUENCE OF INQUIRY BASED COLLABORATIVE INNOVATIVE LEADERSHIP ON LEARNING COMMUNITIES WITH THE MODERATING ROLE OF ORGANIZATIONAL CULTURE

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Abstract: This study analyzes the effect of inquiry-based, collaborative, and innovative leadership on the development of productive learning communities in vocational high schools (SMKs), with organizational culture as a moderating variable. Inquiry-based, collaborative, innovative leadership is a leadership style that encourages teachers to jointly formulate critical questions, reflect on teaching practices, and systematically test new solutions. This approach is expected to strengthen reflective and collaborative practices within teacher learning communities, which often remain formal and administrative. Organizational culture is positioned as a set of school-level values, norms, and routines that can either enhance or hinder collaboration and collective learning. Using a quantitative explanatory approach, the study employed Structural Equation Modeling (SEM) with AMOS 26.0. The sample included 360 productive subject teachers selected through proportionate stratified random sampling from five state vocational high schools in Central Java. The results show that inquiry-based collaboration and organizational culture both have positive and significant effects on productive learning communities. Moreover, their interaction demonstrates a highly significant effect, indicating that an open, collaborative, and learning-oriented organizational culture strengthens the influence of inquiry-based, collaborative, and innovative leadership on teachers' collective learning.
Keywords: Innovative Leadership, Collaborative Inquiry, Organizational Culture, Productive Learning Community, Vocational High School

Abstrak: Penelitian ini bertujuan menganalisis pengaruh kepemimpinan inovatif kolaboratif berbasis inkuiri terhadap pengembangan komunitas belajar produktif di Sekolah Menengah Kejuruan (SMK), dengan budaya organisasi sebagai variabel moderasi. Kepemimpinan inovatif kolaboratif berbasis inkuiri dipahami sebagai gaya kepemimpinan yang mendorong guru untuk bersama-sama merumuskan pertanyaan kritis, merefleksikan praktik pembelajaran, serta menguji solusi baru secara sistematis. Pendekatan ini diharapkan dapat memperkuat praktik reflektif dan kolaboratif dalam komunitas belajar guru yang selama ini cenderung formal dan administratif. Budaya organisasi diposisikan sebagai nilai, norma, dan rutinitas sekolah yang dapat memperkuat atau melemahkan upaya kolaborasi dan pembelajaran kolektif. Penelitian ini menggunakan pendekatan kuantitatif dengan desain eksplanatori dan analisis *Structural Equation Modeling* (SEM) melalui AMOS 26.0. Sampel penelitian terdiri atas 360 guru mata pelajaran produktif yang dipilih melalui *proportionate stratified random sampling* dari lima SMK negeri di Jawa Tengah. Hasil penelitian menunjukkan bahwa kolaborasi berbasis inkuiri dan budaya organisasi berpengaruh positif dan signifikan terhadap komunitas belajar produktif. Interaksi keduanya juga berpengaruh sangat signifikan, menunjukkan bahwa budaya organisasi yang terbuka, kolaboratif, dan berorientasi pada pembelajaran memperkuat pengaruh kepemimpinan inovatif kolaboratif berbasis inkuiri terhadap pembelajaran kolektif guru.
Kata Kunci: Kepemimpinan Inovatif, Inkuiri Kolaboratif, Budaya Organisasi, Komunitas Belajar Produktif, SMK

INTRODUCTION

Vocational education in Indonesia plays a crucial role in developing a skilled and competitive workforce capable of meeting the demands of an increasingly technology-driven economy. However, the effectiveness of vocational education institutions depends not only on their technical training but also on the quality of leadership that shapes teacher learning and organizational development. Traditional leadership models that emphasize administrative control and routine management often fail to foster innovation or collaboration among teachers. In this context, school leadership must evolve approaches that empower teachers to engage in critical inquiry, share best practices, and co-create solutions to educational challenges. Research in educational leadership suggests that effective leaders create environments conducive to professional reflection and innovation (Hallinger, 2011). Vocational schools require leaders who can integrate inquiry, collaboration, and creativity into daily instructional practices. Without such leadership, teacher learning communities remain formalistic and compliance-oriented rather than transformative. As a result, building productive learning communities requires rethinking leadership as a dynamic, participatory, and innovative process. This study responds to that need by examining how innovative leadership grounded in collaborative inquiry can strengthen teacher learning communities in vocational high schools.

Teacher learning communities (TLCs) or professional learning communities (PLCs) have become a cornerstone of continuous teacher development and school improvement. TLCs foster reflective dialogue, peer learning, and joint problem-solving, thereby enhancing instructional quality and student outcomes (Stoll et al., 2006). However, many Indonesian vocational schools have not yet fully realized the potential of TLCs, as these communities often function as administrative groups rather than authentic spaces for professional inquiry (Susilo, 2022). The lack of meaningful collaboration among teachers limits opportunities for pedagogical innovation and interdisciplinary integration. Empirical research shows that strong learning communities are positively associated with teacher efficacy, innovation, and school performance (Wang, Zhang, & Ding, 2023). Thus, leadership that nurtures inquiry and collaboration among teachers is critical to revitalizing TLCs. By shifting the focus from compliance to creativity, leaders can encourage teachers to experiment with new instructional approaches and reflect collectively on their impact. This transformation requires not only leadership vision but also a supportive organizational culture that values openness, trust, and shared learning. The interplay between leadership and culture thus becomes a determining factor in sustaining productive teacher learning communities.

Leadership in educational contexts has long been recognized as a primary driver of teacher performance and school effectiveness. According to Hallinger et al. (2023), leadership influences learning both directly through instructional guidance and indirectly through shaping school climate and teacher collaboration. Recent research further emphasizes that leadership must adapt to complex, knowledge-based environments where

innovation and inquiry are key (Gu et al., 2024). In vocational education, the relevance of innovative leadership is heightened by the sector's dual demands: ensuring practical competence while fostering creativity and problem-solving skills. Leaders who engage teachers in reflective inquiry can transform vocational schools into learning organizations that continuously adapt to industrial change. Conversely, when leadership remains hierarchical, teachers often experience reduced motivation to share knowledge and experiment with new methods (Bush, 2023).

Despite growing attention to leadership and collaboration, most studies on vocational education in Indonesia have focused narrowly on the direct effects of principal leadership on teacher performance. Such an approach neglects complex mechanisms, such as collective inquiry and organizational culture, that mediate the relationship between leadership and learning outcomes. As a result, little is known about how school leaders can systematically cultivate environments where teachers learn from one another. International evidence suggests that schools with strong cultures of inquiry and reflection achieve higher instructional quality and innovation (Harris & Jones, 2018). However, local studies rarely examine how such conditions can be established in vocational contexts that are often characterized by rigid hierarchies and compartmentalized departments. This research gap underscores the need for models that integrate leadership innovation with collaborative learning processes. The current study contributes by proposing and empirically testing such a model using quantitative structural analysis. By doing so, it advances both theoretical understanding and practical strategies for strengthening vocational education through leadership transformation.

Organizational culture serves as the foundation for leadership practices to be enacted and sustained. It encompasses shared values, beliefs, norms, and routines that guide behavior within schools (Schein, 2016). A positive, collaborative organizational culture can amplify leadership's impact on teacher engagement and innovation. Conversely, a culture dominated by hierarchy, conformity, or fear of failure can undermine efforts to build productive learning communities. In vocational schools, where teaching often involves interdisciplinary cooperation and hands-on practice, cultural alignment is essential for effective collaboration. Research indicates that organizational culture moderates the relationship between leadership and teacher performance, particularly in contexts that require teamwork and experimentation (Torres, 2022). Leaders who model openness and trust can foster a climate in which teachers feel safe questioning assumptions and sharing challenges. Thus, organizational culture not only shapes how leadership is perceived but also determines whether collaborative inquiry can thrive. Understanding this moderating role is vital for designing interventions that align leadership and culture toward educational innovation.

Inquiry-based collaborative innovative leadership (IBIL) integrates three essential dimensions of effective school leadership: inquiry, collaboration, and innovation. Inquiry encourages teachers to critically examine their practices, identify problems, and design solutions based on evidence and reflection (Dana & Yendol-Hoppey, 2020). Collaboration ensures that this process is collective rather than individual, emphasizing peer dialogue and shared responsibility. Innovation focuses on generating and testing new ideas to improve teaching and learning outcomes. When combined, these elements create

a leadership approach that transforms schools into communities of inquiry and practice. However, empirical research on IBIL remains limited, especially in the context of vocational education. Few studies have examined how leaders can foster inquiry-based collaboration among teachers to drive innovation systematically. This study fills that gap by investigating how IBIL influences productive learning communities and how organizational culture strengthens or weakens this relationship.

Empirical findings from global research reinforce the significance of linking leadership innovation with school culture. Studies in Europe and Asia reveal that innovative leadership positively correlates with school improvement when embedded in cultures of trust and shared learning (Torres, 2022). In vocational education, this link is even more critical, as teachers must frequently integrate new technologies, curricula, and industry practices. A culture that supports experimentation enables teachers to embrace these changes confidently. Conversely, schools with rigid structures and punitive evaluation systems discourage the risk-taking necessary for innovation. Hence, leadership and culture should be viewed as interdependent variables rather than isolated factors. Understanding their interactions provides deeper insights into how learning communities evolve within complex educational systems. This study addresses that interdependence by positioning organizational culture as a moderating variable between innovative leadership and learning community productivity.

Several empirical gaps still limit the understanding of how innovative leadership operates within vocational contexts. First, most leadership research in Indonesia has been conducted in general education settings, with little focus on vocational institutions that have distinct organizational structures (Lusi & Wahyono, 2020). Second, previous studies have often used descriptive or qualitative approaches, providing valuable insights but limited causal explanations. Third, the moderating effects of organizational culture on leadership outcomes have received minimal empirical testing. Addressing these gaps requires a quantitative, model-based analysis that can simultaneously test the relationships among key variables. Structural Equation Modeling (SEM) offers a robust approach for this purpose, enabling researchers to examine direct and indirect effects among leadership, culture, and learning communities. This methodological advancement allows for the validation of complex theoretical models in real educational settings. The current study applies SEM AMOS to capture these interactions systematically. In doing so, it extends both the conceptual and empirical literature on vocational school leadership in Indonesia.

From a policy perspective, strengthening innovative leadership in vocational education supports Indonesia's broader educational reform agenda under Merdeka Belajar. The initiative emphasizes teacher autonomy, collaboration, and creativity as key elements of quality improvement. However, achieving these objectives requires not only policy directives but also evidence-based leadership models that fit the vocational context. This study provides empirical support for such models by demonstrating how inquiry-based collaboration enhances teacher learning and how culture amplifies these effects. Policymakers can use this evidence to design leadership development frameworks that emphasize reflective practice and cross-disciplinary teamwork. Furthermore,

vocational education supervisors can leverage the study's findings to foster alignment between institutional goals and everyday teaching practices.

In summary, this study positions inquiry-based, collaborative, and innovative leadership as a critical factor in developing productive learning communities in vocational high schools. It also identifies organizational culture as a moderating variable that strengthens this relationship by creating conditions conducive to collaboration, reflection, and innovation. The theoretical contribution lies in integrating leadership and culture within a single model of professional learning community development. The methodological contribution involves the use of SEM AMOS to test complex relationships empirically. The practical contribution is providing evidence-based guidance for school leaders and policymakers to enhance the quality of vocational education. By addressing the gaps in existing research and providing a novel analytical framework, this study adds both conceptual and practical value to educational leadership literature. Ultimately, it argues that vocational schools can become centers of innovation when leadership and culture work in synergy. Thus, the study not only contributes to academic discourse but also supports transformative change in Indonesia's vocational education system.

LITERATURE REVIEW
Innovative Leadership

Innovative leadership in education refers to a leader's ability to drive transformation through creativity, collaboration, and systematic reflection to enhance the quality of teaching and learning. Hallinger (2011) emphasizes that innovative educational leaders are not merely administrators but agents of change who nurture a culture of inquiry and professional growth within schools (Hojeij, 2024). This leadership style is characterized by a clear vision for reform, adaptability to evolving educational demands, and the willingness to take strategic risks to encourage pedagogical innovation. A systematic review by Rafidah et al. (2025) categorizes innovative leadership into four essential dimensions: transformational, visionary, instructional, and collaborative, each contributing to a creative and dynamic professional environment. Mukhtar et al. (2025) propose an integrated framework of innovative education that highlights digital transformation, teacher professional development, and adaptive change management as leadership central to achieving educational modernization. In the technical and vocational education and training (TVET) context, Dianawati et al. (2025) stress that innovation is crucial for aligning school curricula with rapidly evolving industry leadership standards and technological change. Hence, innovative leadership forms the foundation for developing adaptive, future-ready vocational schools capable of responding to industrial transformation.

In Indonesia, the implementation of innovative leadership has become a strategic priority in modern educational management. Empirical research by Chaerunnisa et al. (2022) demonstrates that innovative leadership positively and significantly affects the culture of innovation and teacher performance in public vocational schools across Central Java. Similarly, found that principals with innovative leadership styles in Yogyakarta vocational schools enhanced teacher creativity and collaboration through reflective

practice and project-based learning. Despite these encouraging findings, most Indonesian studies remain limited to examining the direct effects of leadership on teacher performance without investigating how innovative leadership operates through collaborative inquiry within teacher learning communities. Moreover, empirical evidence on the interaction between innovative leadership and organizational culture in vocational education remains scarce, even though a supportive culture is essential for sustaining innovation. This research gap underscores the need to position inquiry-based, collaborative, and innovative leadership as a key construct for developing productive learning communities in vocational schools, with organizational culture as a moderating factor that amplifies its impact.

Learning Communities

Professional Learning Communities (PLCs) are commonly defined as collaborative groups of educators who engage in continuous, reflective inquiry to improve teaching and student outcomes through shared goals, collective responsibility, and evidence-informed dialogue. Classic syntheses argue that PLCs build "capacity" by aligning teacher motivation, professional skills, and supportive organizational conditions, thereby sustaining improvement over time (Stoll et al, 2006). Recent quantitative work in Finland shows that PLC maturity is closely associated with cultures of collegiality, trust, and commitment, underscoring that PLCs are as much a cultural transformation as they are a structural arrangement. Together, these strands position PLCs as a core mechanism linking professional development to school-wide innovation and instructional quality.

Within vocational/TVET contexts, PLCs face distinctive demands: teachers must integrate theoretical knowledge with rapidly changing industry practices, coordinate interdisciplinary projects, and adapt to technology adoption cycles. Policy and systems evidence for Indonesia highlights the breadth and diversity of the vocational sector, suggesting significant variation in school readiness to implement PLCs. Empirical work in Indonesian vocational schools further indicates that teacher professional development and interpersonal communication, two foundations of PLC functioning, are associated with better teaching performance, suggesting that PLC-like processes are consequential for instructional improvement. These studies collectively indicate that PLC effectiveness in SMKs hinges on both collaborative structures and enabling conditions (time, trust, facilitation, data use) tailored to vocational realities (Voctech, 2020).

A growing body of research links leadership to PLC vitality, showing that collaborative or distributed leadership strengthens teacher collaboration, collective efficacy, and innovation processes central to healthy learning communities. Large-scale and cross-regional studies report that when teachers trust leaders and peers, leadership effects on collective innovativeness and PLC outcomes are amplified; conversely, without such social capital, PLCs risk becoming rather procedural than developmental. These findings imply that leadership is most potent when embedded in cultures of inquiry and trust, reinforcing the rationale for testing organizational culture as a moderator of leadership PLC relationships in vocational schools. This paper builds on that evidence base to argue for an inquiry-driven, collaborative leadership model whose effects on PLC productivity are contingent on the school's cultural climate (Cao et al., 2025).

Organizational Culture

Organizational culture in schools is generally understood as a system of shared values, beliefs, norms, and routines that shapes how members think, act, and interact in pursuit of educational goals. It provides the "taken-for-granted" assumptions that guide behavior and decision-making, thereby playing a central role in how teaching, learning, and change processes unfold (Teasley, 2017). In the school context, recent work conceptualises school organizational culture as a multidimensional construct, including collaborative practices, shared vision, and an orientation to learning, that both influences and is influenced by leadership processes (Torres, 2022). Their review proposes that culture is not merely a background variable but a key analytical lens for understanding how leadership initiatives translate into sustained school improvement. Similarly, Atlantis Press publications on school organizational culture underline that culture is fundamental for school effectiveness and improvement, arguing that strengthening participation, symbolic actions, and recognition mechanisms are crucial levers for cultural change in vocational leadership schools (Widiawati et al., 2024). Taken together, this literature positions organizational culture as a core determinant of whether leadership, professional development, or policy reforms can actually take root within school life.

Within technical and vocational education and training (TVET), organizational culture has been identified as a decisive factor in program quality and institutional effectiveness. A recent systematic review of organizational culture in TVET programs across Africa, Asia, and Europe concludes that cultural strengths, such as openness to innovation, collaboration with industry, and learner-centred values, are directly linked to program efficacy. In contrast, rigid or fragmented cultures undermine responsiveness to labor market needs (Alanazi et al., 2025). Complementary work on TVET in Indonesia and other middle-income countries argues that the success of vocational institutions in supporting socioeconomic development depends not only on infrastructure and curriculum but also on the underlying culture that governs how teachers, leaders, and external partners work together (Moses, 2018). In this strand of research, organizational culture is increasingly framed as part of the "hidden architecture" of TVET institutions, enabling or constraining innovation, collaboration, and adaptation. Yet, despite this recognition, relatively few quantitative studies explicitly test organizational culture as a moderating or mediating variable in models linking leadership to learning communities or other professional learning outcomes.

In Indonesian vocational high schools (SMKs), empirical evidence confirms that organizational culture is strongly associated with teacher behavior and performance. Studies in Malang, Medan, Jakarta, and other regions show that more positive school cultures, characterized by shared goals, discipline, and supportive norms, have significant direct effects on teachers' work discipline, motivation, and performance in SMKs (Mintaasih. A meta-analysis of Indonesian studies from 2018–2023 similarly concludes that organizational culture consistently predicts educator performance across educational levels. Research on vocational schools in East Jakarta finds that organizational culture, alongside leadership style, influences work motivation and, in turn, impacts teacher performance, reinforcing the view that culture operates as a key contextual factor in vocational institutions (Sinambela et al., 2019). More recent work goes further, showing

that in some SMKs, school culture not only affects performance directly but also interacts with leadership, for example, moderating the influence of principal leadership on teacher outcomes (Sanusi, 2023). However, few of these studies explicitly link organizational culture to learning communities or examine its moderating role in the relationship between innovative, inquiry-based leadership and the productivity of teacher learning communities in vocational schools. This empirical gap underlines the relevance and originality of positioning organizational culture as a moderating variable in the present study's model.

RESEARCH METHODOLOGY

This study employed a quantitative explanatory research design to examine causal relationships among the latent variables of inquiry-based collaborative innovative leadership, organizational culture, and productive learning communities. An explanatory design was chosen because it enables researchers not only to identify statistical associations but also to test theoretically derived causal paths among constructs using a structural modeling framework. This methodological choice aligns with recommendations from structural equation modeling (SEM) scholars who argue that explanatory designs are most appropriate when a study aims to compare competing theoretical models, estimate both direct and indirect effects, and examine complex moderating relationships within a single analytic framework. SEM was chosen over multiple regression or path analysis because SEM allows the simultaneous estimation of measurement models and structural paths, thereby minimizing measurement error and yielding more robust causal inferences. AMOS version 26.0 was used because it provides covariance-based SEM analysis, graphical model building, and advanced moderation testing techniques suitable for educational leadership research, where constructs are latent and multidimensional. The use of SEM also reflects the theoretical complexity of the model, which integrates leadership, culture, and learning community dynamic variables that cannot be adequately captured through conventional statistical methods.

The research population consisted of 780 productive subject teachers from five state vocational high schools (SMK Negeri) in Central Java Province. Teachers from productive subjects were selected because they are the actors most directly involved in implementing industry-linked curricula and collaborative instructional practices, making them a theoretically appropriate population for examining leadership and learning communities. The sample size of 360 respondents was determined using Slovin's formula at a 5% margin of error. This sample meets and exceeds methodological recommendations for SEM, which require: (1) a minimum sample of 200 cases, or (2) 10–15 respondents per indicator, and (3) an additional 20% sample increase when a model includes moderating effects to enhance stability of parameter estimates. To ensure representativeness across fields of specialization, the study employed Proportionate Stratified Random Sampling, stratifying the population by expertise areas including automotive engineering, hospitality, computer and network engineering, online business and marketing, and accounting and finance. This sampling strategy was necessary to avoid cluster bias and ensure that variability within each specialty was proportionally reflected in the final dataset.

The study analyzed three latent constructs: inquiry-based, collaborative, and innovative leadership (X); organizational culture (Z, as the moderating variable); and productive learning communities (Y) as the dependent variable. Inquiry-based, collaborative, and innovative leadership refers to the principal's capacity to facilitate reflective inquiry, promote teacher collaboration, and stimulate the exploration of new teaching strategies. Organizational culture represents the shared norms, values, and beliefs that shape collaborative behavior and the learning climate within schools. Productive learning communities capture the depth of teacher collaboration, reflective practices, and innovation in teaching improvement.

Each construct was operationalized using indicators adapted from Hallinger (2011) for leadership, Schein (2016) for organizational culture, and Stoll et al (2006) for learning communities. A five-point Likert scale (1 = strongly disagree to 5 = strongly agree) was used to quantify responses. Instrument development followed a rigorous process: (1) content validity was established by three experts in education management, who evaluated item-to-construct alignment; (2) a pilot test with 30 teachers was conducted to examine clarity and factor structure; (3) Confirmatory Factor Analysis (CFA) was used to evaluate construct validity, requiring factor loadings ≥ 0.60; (4) reliability was assessed using Composite Reliability (CR ≥ 0.70) and Average Variance Extracted (AVE ≥ 0.50). All items met the psychometric criteria, indicating that the instrument was valid and reliable for full data collection.

Data were collected through a structured, closed-ended questionnaire, administered both online and offline to accommodate the varying technological capacities of the participating schools. Before data collection, formal permission was obtained from each school principal, and informed consent was secured from all participants. Respondents were briefed on the study's objectives, confidentiality measures, and their rights to voluntary participation. Data were collected over four weeks to avoid workload bias and to ensure high response quality. The combination of online and paper-based distribution increased accessibility and minimized non-response bias, which is particularly important when studying vocational teachers who often have irregular schedules due to industry-aligned teaching obligations.

Data analysis followed a multi-stage procedure consistent with best practices in SEM. First, assumption testing was conducted, including checks for: (1) multivariate normality, evaluated using skewness and kurtosis ratios within ±2.58; (2) multivariate outliers, using identified Mahalanobis Distance at $p < 0.001$; and (3) multicollinearity, assessed through Variance Inflation Factor (VIF < 10). Second, the measurement model was evaluated using CFA to assess convergent and discriminant validity. Third, Goodness of Fit (GoF) indices were examined to determine model acceptability: $\chi^2/df \leq 3$, RMSEA ≤ 0.08, GFI ≥ 0.90, AGFI ≥ 0.90, CFI ≥ 0.95, and TLI ≥ 0.90. These indicators were selected because they represent widely accepted benchmarks for SEM, balancing model parsimony and explanatory adequacy. Fourth, the structural model was analyzed to test hypotheses concerning direct effects and moderating effects. Moderation testing was performed by creating a mean-centered interaction term (X × Z) to reduce multicollinearity and estimate the interaction effect on Y. Statistical significance was determined at $p < 0.05$, and standardized path coefficients were interpreted to assess

effect magnitude. SEM AMOS was chosen over alternatives such as PLS-SEM because the research aimed to validate a theory-driven model rather than to predict variance, making covariance-based SEM a more appropriate analytic strategy.

FINDINGS AND DISCUSSION
Findings

The results of the data analysis using Structural Equation Modeling (SEM) with AMOS 26.0 produced two model comparisons: a non-moderated model and a moderated model in which organizational culture serves as a moderator. The evaluation of model fit indices is summarized in Table 1.

Table 1. Goodness of fit indices

Fit Index	Non-Moderated Model	Moderated Model	General Threshold	Description
Chi-Square	230.521	247.577	$< 3 \times df$	Fit
Probability (p)	0.000	0.000	≥ 0.05	Not significant (acceptable for large SEM Models)
GFI	0.885	0.879	≥ 0.80	Good
AGFI	0.815	0.808	≥ 0.80	Acceptable
RMSEA	0.122	0.114	≤ 0.08–0.10	Fair
TLI	0.944	0.952	≥ 0.90	Good
NFI	0.950	0.956	≥ 0.90	Very Good
PCFI	0.714	0.716	≥ 0.50	Acceptable
PNFI	0.708	0.710	≥ 0.50	Acceptable

The moderated model demonstrates a better overall fit than the non-moderated model, as indicated by higher TLI (0.952) and NFI (0.956) indices. This improvement confirms that incorporating organizational culture as a moderating variable enhances the model's explanatory power and better represents the empirical data.

Table 2. Standardized regression weights and loading factors

Relationship Between Variables	Path Coefficient	t-value / CR	Description
Collaborative Inquiry → Learning Community	0.54	6.82	Significant
Organizational Culture → Learning Community	0.54	6.52	Significant
Collaborative Inquiry × Organizational Culture → Moderation Effect	1.00	10.41	High Significant

Moderation Effect → Learning Community	0.20	2.17	Significant
X1–X5 → Collaborative Inquiry	1.00–1.05	>1.96	Valid
Z1–Z4 → Organizational Culture	1.00–1.35	>1.96	Valid
Y1–Y4 → Learning Community	0.94–1.08	>1.96	Valid

The results of the path coefficient analysis indicate that collaborative inquiry has a positive and significant effect on the learning community (β = 0.54; CR = 6.82). Similarly, organizational culture also significantly affects the learning community (β = 0.54; CR = 6.52). Furthermore, the interaction effect between collaborative inquiry and organizational culture (CR = 10.41) is highly significant, confirming the moderating role of organizational culture in strengthening the relationship between collaborative inquiry and learning community development.

All indicators for each construct demonstrated factor loadings greater than 1.96, indicating that the measurement model is valid and reliable for further interpretation. Overall, these findings affirm that organizational culture enhances the impact of inquiry-based, collaborative, and innovative leadership on the formation of productive learning communities in vocational schools.
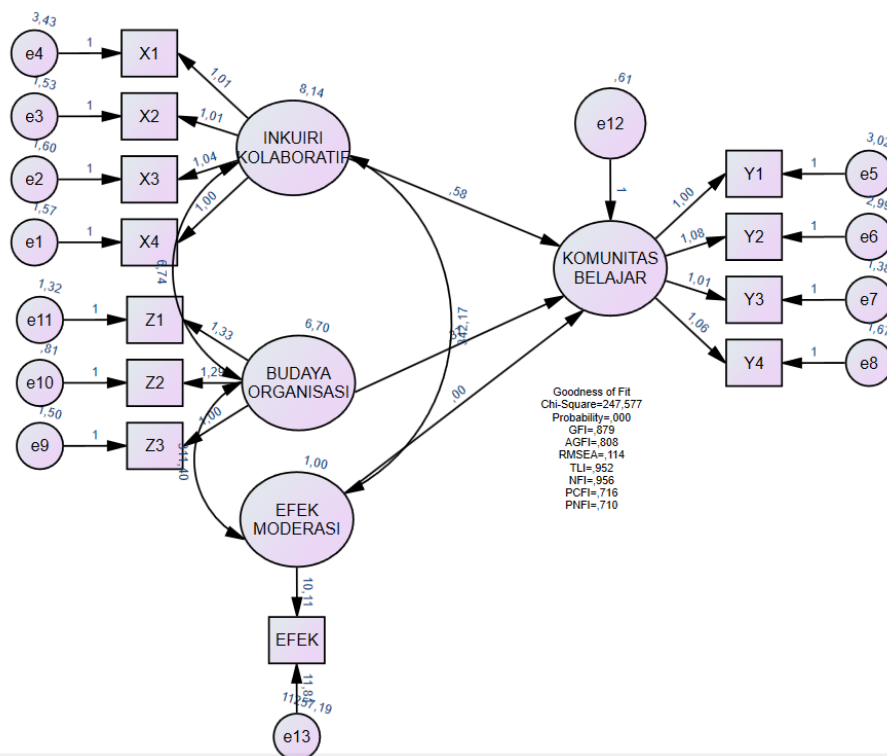

Figure 1. The relationship between collaborative inquiry and learning communities as moderated by organizational culture

DISCUSSION

The findings of this study demonstrate that inquiry-based, collaborative, innovative leadership plays a decisive role in strengthening productive learning communities within

vocational high schools, and that the magnitude of this influence increases significantly when enacted within a supportive organizational culture. It aligns with the central research aim, which was not only to test the direct effects of leadership and organizational culture on learning communities, but also to understand how the two interact to shape teachers' collective learning practices. The results suggest that productive learning communities in vocational schools do not arise from isolated leadership practices or cultural characteristics alone. Rather, they emerge from the synergistic interaction between collaborative inquiry-driven leadership and a conducive cultural environment. It confirms that teacher learning is inherently relational and organizational, shaped not only by leadership actions but also by the cultural meanings and norms that guide professional behavior.

The positive influence of inquiry-based, collaborative, and innovative leadership can be understood through social constructivist theory, which posits that knowledge is created through social interaction, reflective dialogue, and shared problem-solving. In vocational school contexts, teachers must continually adapt to evolving industry needs. Leaders who encourage critical questioning, evidence-informed reflection, and experimentation are effectively constructing the social foundations for ongoing professional learning. This interpretation aligns with Hallinger's (2011) argument that educational leadership is not limited to issuing directives but also requires creating collaborative inquiry structures that empower teachers as co-learners. The relatively strong path coefficient observed in the structural model reflects the substantial impact of such inquiry-driven leadership practices on the intensity and quality of teacher collaboration. When leadership normalizes inquiry as an everyday practice, learning communities shift from procedural to transformative, enabling teachers to collectively construct new knowledge relevant to their instructional challenges.

The strong direct effect of organizational culture further reinforces its critical role as the "hidden architecture" of schools, as Schein (2016) describes it. Culture shapes how teachers interpret leadership practices, how they interact with colleagues, and how willing they are to take risks, share vulnerabilities, and innovate. In schools where norms emphasize trust, openness, and shared learning, teachers develop a sense of psychological safety that allows them to participate authentically in collective inquiry. As Torres (2022) suggests, learning communities thrive in cultures that value collaboration and reflection but struggle in cultures dominated by hierarchy, conformity, or fear of failure. The present findings support this view by showing that teachers in culturally supportive environments engage more deeply in collaborative learning processes, transforming learning communities into meaningful spaces of professional growth rather than administrative routines.

From a methodological perspective, the statistical results of this study substantially reinforce the validity of the substantive interpretations. The improvement in TLI and NFI in the moderated model indicates that incorporating the interaction between collaborative inquiry and organizational culture enhances the model's explanatory power rather than merely adding technical complexity. High incremental fit values (TLI > 0.95; NFI > 0.95) demonstrate that the model closely reflects empirical realities in vocational schools. While the RMSEA value is slightly above the ideal threshold, such levels remain

acceptable for models with multiple latent constructs and complex measurement structures. Within the SEM framework, this combination of fit indices suggests that the proposed interactive relationships are not only theoretically sound but also empirically robust, providing strong statistical grounding for the argument that learning dynamics in vocational schools are better captured through interactive rather than linear models.

The significance of the path coefficients, including the strong and highly significant moderating effect, provides deeper evidence of the interplay between leadership and culture. The exceptionally high Critical Ratio for the moderating term indicates that organizational culture does more than slightly enhance leadership influence; it substantially changes the nature of the relationship between leadership and learning communities. In culturally open and collaborative schools, inquiry-driven leadership finds fertile ground and exerts much greater impact, whereas in rigid or hierarchical cultures, similar leadership efforts are likely to be resisted or reduced to symbolic gestures. It reflects the essence of contingency theory, which asserts that leadership effectiveness depends on its alignment with the organizational context. The moderating effect observed in this study is significant enough to suggest that culture is not a background factor but an active force that shapes how teachers respond to leadership. This finding advances the theoretical understanding of vocational school leadership by demonstrating that leadership and culture must be viewed as interdependent, not independent, variables.

Furthermore, the consistently high factor loadings across all indicators indicate that the constructs of collaborative inquiry, organizational culture, and productive learning communities are strongly represented in respondents' perceptions. It enhances measurement reliability and strengthens confidence that the structural relationships reflect genuine patterns in school life rather than statistical artifacts. In methodological terms, strong loadings reduce measurement error, enabling more precise interpretation of the structural and moderating relationships.

Compared with previous studies, the present findings both confirm and extend existing knowledge. International research consistently shows that collaborative and distributed leadership enhances professional learning, innovation, and school improvement (Bush, 2023; Gu et al., 2024; Harris & Jones, 2018). This study confirms those conclusions in the Indonesian vocational context but goes further by demonstrating that leadership is most powerful when reinforced by a supportive organizational culture. In contrast to earlier research, which suggests that vocational teacher groups often function more as administrative bodies than authentic learning communities (Susilo, 2022), the present findings reveal that these limitations stem more from misalignment between leadership practices and cultural norms than from vocational education's inherent characteristics. When inquiry-driven leadership is paired with a learning-oriented culture, vocational schools can cultivate robust learning communities.

The strength of the moderated model underscores the complex, multi-layered nature of organizational learning in vocational schools. As Harris (2018) notes, modern educational organizations cannot be understood through linear cause-and-effect models, as leadership, culture, and collaboration interact in dynamic, reciprocal ways. The statistical improvement of the moderated model supports this claim and suggests that

vocational education in Indonesia is evolving toward more complex, learning-oriented organizational forms. It has important theoretical implications: innovative leadership cannot be understood without considering school culture, and culture cannot be fully understood without considering how leadership shapes and is shaped by it. This interdependence resonates with Senge's concept of the learning organization, where adaptive learning emerges when shared norms, values, and professional practices support ongoing experimentation and reflective inquiry.

These findings further emphasize that productive learning communities are shaped not merely by leadership actions but by the cultural milieu in which these actions are enacted. The strong and significant relationship between collaborative inquiry and learning communities aligns with international evidence indicating that professional learning becomes more meaningful when grounded in shared inquiry, reflective dialogue, and collective problem-solving. Vangrieken et al. (2017) conclude that collaborative inquiry enhances teachers' sense of collective responsibility and fosters deeper professional relationships, enabling them to co-construct pedagogical knowledge more effectively. Similarly, Lee and Louis (2019) found that inquiry-based collaboration strengthens collective efficacy and professional trust, both of which are central to the vitality of learning communities. These findings align closely with this study's results, which show that inquiry-driven leadership significantly enhances teachers' collaborative learning behaviors, demonstrating that inquiry serves as a key mechanism for transforming vocational schools into active learning communities.

The moderating role of organizational culture also deepens the theoretical understanding of how leadership practices shape collective learning. Thien et al. (2022) show that cultures emphasizing openness, trust, and shared learning significantly amplify leadership's positive influence on teacher collaboration, whereas hierarchical or compliance-oriented cultures tend to suppress such effects. Liu et al. (2020) similarly reveal that supportive organizational cultures intensify the influence of distributed and inquiry-based leadership on teachers' innovation behaviors, indicating that leadership operates most effectively within cultures that encourage experimentation and collegial risk-taking. These findings closely mirror the empirical pattern observed in this study, in which organizational culture significantly strengthens the effects of collaborative inquiry on learning community development. Therefore, leadership effectiveness in vocational schools cannot be viewed in isolation; instead, it depends on the alignment between inquiry-oriented leadership practices and a culture that values reflection, collaboration, and continuous learning.

Overall, the combined theoretical and statistical evidence from this study emphasizes that productive learning communities in vocational schools emerge from the complex interaction between inquiry-driven leadership and a supportive organizational culture. Leadership provides the structural and cognitive impetus for teacher collaboration, while culture offers the psychological and normative space that allows it to flourish. When both elements are aligned, vocational schools can transform into adaptive learning organizations capable of responding to industrial change, supporting sustained teacher professional development, and enhancing educational quality. The findings thus offer not only empirical support for improving leadership and culture in vocational

schools but also significant contributions to the broader discourse on how organizational learning can be strengthened through the integration of structural and cultural strategies.

CONCLUSION

This study concludes that inquiry-based, collaborative, innovative leadership, when supported by an open and learning-oriented organizational culture, serves as a powerful catalyst for strengthening productive learning communities in vocational schools, as evidenced by the robust statistical relationships and moderating effects identified in the model. The findings confirm that teacher learning is not merely an individual endeavor but a collective process shaped by leadership practices that promote inquiry, reflection, and experimentation, and by cultural norms that create psychological safety and shared responsibility. Scientifically, this research advances leadership and organizational learning theory by integrating leadership and culture into a single explanatory framework, demonstrating that their interactions offer deeper insights than examining either factor in isolation. Practically, the study underscores the need for vocational school leaders and policymakers to cultivate cultures that encourage collaboration and innovation, thereby enabling schools to function as adaptive learning organizations capable of responding to rapid industrial and technological change. Future research should expand this model by exploring additional contextual variables, such as digital leadership, teacher autonomy, and industry partnerships, and by applying longitudinal or mixed-methods designs to capture the evolving dynamics of leadership, culture, and professional learning over time.

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